Reversible processes in fluid system [tln15]

Isothermal process: $T = \text{const.}$ $\quad \delta Q \neq 0$ in general.

Isochoric process: $V = \text{const.}$ $\quad \delta Q = C_V dT,\ dU = C_V dT.$

Isobaric process: $p = \text{const.}$ $\quad \delta Q = C_p dT.$

Isentropic (adiabatic) process: $S = \text{const.}$ $\quad \delta Q = 0.$

Internal energy: $dU = \delta Q + \delta W = TdS - pdV.$

- $V = \text{const.} \ \Rightarrow\ \delta W = 0 \ \Rightarrow\ dU = \delta Q$ (no work performed).
- $S = \text{const.} \ \Rightarrow\ \delta Q = 0 \ \Rightarrow\ dU = \delta W$ (no heat transferred).

Classical ideal gas:

Equation of state: $pV = nRT.$

Internal energy: $U = C_V T,\ C_V = \alpha n R = \text{const.}$

Isotherm: $T = \text{const.} \ \Rightarrow\ pV = \text{const.}$

Adiabate: $S = \text{const.} \ \Rightarrow\ pV^\gamma = \text{const.},\ \gamma = 1 + 1/\alpha$

- monatomic gas: $\alpha = \frac{3}{2},\ \gamma = \frac{5}{3}.$
- diatomic gas: $\alpha = \frac{5}{2},\ \gamma = \frac{7}{5}.$
- polyatomic gas: $\alpha = 3,\ \gamma = \frac{4}{3}.$